

CLAIMS

We claim:

1. Subscriber-line interface circuitry (SLIC) for connecting customer premises equipment (CPE) to a telecommunications network via a tip-and-ring line pair, comprising:

5 audio-feeding circuitry adapted to transmit and receive audio signals to and from the CPE via the tip and ring lines; and

ringing circuitry adapted to provide a ringing signal to the CPE via the ring line, wherein:

10 an output side of the audio-feeding circuitry includes a tip amplifier adapted to be connected to the tip line; and

the SLIC is adapted to return the ringing signal from the CPE via the tip line and through the tip amplifier.

2. The invention of claim 1, wherein the SLIC comprises:

15 a first switch connected to provide a selectable connection between a ringing signal source and the ring line; and

a second switch connected to provide a selectable connection between an output of a ring amplifier of the audio-feeding circuitry and the ring line, wherein, during ringing, the first switch is closed, such that the ringing signal from the ringing signal source is returned through the tip amplifier.

20 3. The invention of claim 2, wherein, during ringing, the second switch is open.

4. The invention of claim 2, wherein the SLIC further comprises a third switch connected to provide a selectable connection between an output of the tip amplifier and the tip line, wherein, during ringing, the third switch is closed.

25 5. The invention of claim 1, wherein the ringing signal is returned to ground voltage through the tip amplifier.

30 6. The invention of claim 1, wherein the ringing signal is returned to battery voltage through the tip amplifier.

7. The invention of claim 1, wherein the tip amplifier is driven into saturation during ringing.

8. The invention of claim 7, wherein the tip amplifier is driven to saturation at ground voltage during ringing.

5 9. The invention of claim 7, wherein the tip amplifier is driven to saturation at battery voltage during ringing.

10 10. The invention of claim 1, wherein the tip amp comprises:

 a first diode D1 connected between a tip signal node N1 and a ground voltage and oriented to allow current to flow from the tip signal node to the ground voltage;

15 a first transistor T1, whose channel terminals are connected between the tip signal node and the ground voltage;

 a second diode D2 connected between the tip signal node and a battery voltage and oriented to allow current to flow from the battery voltage to the tip signal node; and

 a second transistor T1, whose channel terminals are connected between the tip signal node and the battery voltage.

20 11. The invention of claim 10, wherein, during ringing, the first transistor is turned on and the second transistor is turned off to return the ringing signal to the ground voltage.

25 12. The invention of claim 10, wherein, during ringing, the first transistor is turned off and the second transistor is turned on to return the ringing signal to the battery voltage.

30 13. The invention of claim 1, wherein the SLIC is implemented in an integrated circuit.

25 14. The invention of claim 1, wherein:

 the SLIC comprises:

 a first switch connected to provide a selectable connection between a ringing signal source and the ring line;

30 a second switch connected to provide a selectable connection between an output of a ring amplifier of the audio-feeding circuitry and the ring line; and

 a third switch connected to provide a selectable connection between an output of the tip amplifier and the tip line, wherein, during ringing, the first and third switches are closed and the second switch is open, such that the ringing signal from the ringing signal source is returned through the tip amplifier;

 the tip amplifier is driven into saturation during ringing; and

the tip amp comprises:

a first diode D1 connected between a tip signal node N1 and a ground voltage and oriented to allow current to flow from the tip signal node to the ground voltage;

5 a first transistor T1, whose channel terminals are connected between the tip signal node and the ground voltage;

a second diode D2 connected between the tip signal node and a battery voltage and oriented to allow current to flow from the battery voltage to the tip signal node; and

10 a second transistor T1, whose channel terminals are connected between the tip signal node and the battery voltage, wherein:

in a first mode of operation, during ringing, the first transistor is turned on and the second transistor is turned off to return the ringing signal to the ground voltage; and

in a second mode of operation, during ringing, the first transistor is turned off and the second transistor is turned on to return the ringing signal to the battery voltage.

15 15. In a telecommunications network, a method for interfacing with customer premises equipment (CPE) via a tip-and-ring line pair, comprising:

providing a ringing signal to the CPE via the ring line; and

receiving the ringing signal from the CPE via the tip line, wherein the ringing signal is returned through a tip amplifier of subscriber-line interface circuitry (SLIC) of the telecommunications network.

20 16. The invention of claim 15, wherein the SLIC comprises:

a first switch connected to provide a selectable connection between a ringing signal source and the ring line; and

25 a second switch connected to provide a selectable connection between an output of a ring amplifier of the audio-feeding circuitry and the ring line, wherein, during ringing, the first switch is closed, such that the ringing signal from the ringing signal source is returned through the tip amplifier.

17. The invention of claim 16, wherein, during ringing, the second switch is open.

30 18. The invention of claim 16, wherein the SLIC further comprises a third switch connected to provide a selectable connection between an output of the tip amplifier and the tip line, wherein, during ringing, the third switch is closed.

19. The invention of claim 15, wherein the ringing signal is returned to ground voltage through the tip amplifier.

5 20. The invention of claim 15, wherein the ringing signal is returned to battery voltage through the tip amplifier.

21. The invention of claim 15, wherein the tip amplifier is driven into saturation during ringing.

10 22. The invention of claim 21, wherein the tip amplifier is driven to saturation at ground voltage during ringing.

23. The invention of claim 21, wherein the tip amplifier is driven to saturation at battery voltage during ringing.

15 24. The invention of claim 15, wherein the tip amp comprises:

a first diode D1 connected between a tip signal node N1 and a ground voltage and oriented to allow current to flow from the tip signal node to the ground voltage;

a first transistor T1, whose channel terminals are connected between the tip signal node and the ground voltage;

20 a second diode D2 connected between the tip signal node and a battery voltage and oriented to allow current to flow from the battery voltage to the tip signal node; and

a second transistor T1, whose channel terminals are connected between the tip signal node and the battery voltage.

25 25. The invention of claim 24, wherein, during ringing, the first transistor is turned on and the second transistor is turned off to return the ringing signal to the ground voltage.

26. The invention of claim 24, wherein, during ringing, the first transistor is turned off and the second transistor is turned on to return the ringing signal to the battery voltage.

30 27. The invention of claim 15, wherein the SLIC is implemented in an integrated circuit.

28. The invention of claim 15, wherein:

the SLIC comprises:

a first switch connected to provide a selectable connection between a ringing signal source and the ring line;

5 a second switch connected to provide a selectable connection between an output of a ring amplifier of the audio-feeding circuitry and the ring line; and

 a third switch connected to provide a selectable connection between an output of the tip amplifier and the tip line, wherein, during ringing, the first and third switches are closed and the second switch is open, such that the ringing signal from the ringing signal source is returned through the tip amplifier;

 the tip amplifier is driven into saturation during ringing; and

 the tip amp comprises:

10 a first diode D1 connected between a tip signal node N1 and a ground voltage and oriented to allow current to flow from the tip signal node to the ground voltage;

 a first transistor T1, whose channel terminals are connected between the tip signal node and the ground voltage;

15 a second diode D2 connected between the tip signal node and a battery voltage and oriented to allow current to flow from the battery voltage to the tip signal node; and

 a second transistor T1, whose channel terminals are connected between the tip signal node and the battery voltage, wherein:

 in a first mode of operation, during ringing, the first transistor is turned on and the second transistor is turned off to return the ringing signal to the ground voltage; and

20 in a second mode of operation, during ringing, the first transistor is turned off and the second transistor is turned on to return the ringing signal to the battery voltage.